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Economic Costs of Obesity to Self-Insured Employers

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Objective: *To quantify the direct and indirect costs of obesity within a cohort of commercially insured employees in the United States.* ***Method:*** *Health plan claims, self-reported health risk assessment, and productivity data (Thomson MarketScan) from 2003 to 2005 were used to identify employees. Two-part regression models were used to compare body mass index (BMI) groups to estimate the incremental direct and indirect costs, conditional on expenditure, associated with elevated BMI.* ***Results:*** *Regression-adjusted incremental direct medical costs associated with being overweight, obese, and severely obese were estimated to be $147.11, $712.34, and $1977.43, respectively. Adjusted incremental indirect costs due to paid absence associated with being overweight, obese, and severely obese were estimated at $1403.81, $1511.24, and $1414.09, respectively.* ***Conclusions:*** *Overall adjusted direct and indirect costs were higher for workers with elevated BMI relative to those of normal weight.* (J Occup Environ Med. *2008;50: 991–997*)

The increased prevalence of overweight and obesity in the United States over the past two decades is well documented.[1] Data from the National Health and Nutrition Examination Surveys indicate that the prevalence of obesity among adults aged 20 to 74 rose from 15.0% in the late 1970s to 32.9% in 2003 to 2004.[2,3] Recent estimates indicate that approximately two thirds of adults aged 20 and older in the United States are either overweight or obese, based on a body mass index (BMI) greater than 25.0.[4,5] This trend in population body weight has contributed to growth in the prevalence of a variety of chronic health conditions widely recognized as primary drivers of premature morbidity, mortality, and health-related spending in the United States,[6] including type 2 diabetes, cardiovascular disease, hypertension, and osteoarthritis.[7] Estimates of the annual deaths attributable to obesity range from 112,000 to 300,000.[8,9]

A number of studies have estimated the costs of obesity as the sum of the costs attributable to obesity-related chronic conditions, such as type 2 diabetes, cardiovascular disease, gallbladder disease, and osteoarthritis.[10,11,12] Following this approach, Wolf and Colditz[10] estimated the total US costs of obesity, direct and indirect, at approximately $99 billion for 1995. Direct medical costs were estimated to be $51.6 billion, or 5.7% of the national health care expenditure, with obesity 2.7 times more costly than hypertension, 1.25 times more costly than coronary heart disease, and approximately the

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DOI: 10.1097/JOM.0b013e318182f730

same as diabetes. Finkelstein et al found that the direct medical expenditures of obese adults aged 18 to 65 were 36% higher than those of adults the same age whose weight was normal.[11] Thorpe et al[13] recently estimated that the proportion of private health care spending attributable to obesity increased from 2% (about $3.6 billion) in 1987 to 11.6% (about $36.5 billion) in 2002.

Although a number of estimates of the direct medical expenditures attributable to obesity are available, less is known about the indirect costs of obesity due to lost productivity. Workplace studies suggest that, in general, direct medical costs account for less than half of the total health and productivity-related expenditures faced by employers.[14] Data from the National Health Interview Survey suggest that the cost of lost productivity attributable to obesity in 1995 was $3.9 billion. Consistent with the increased prevalence of obesity over past decades, this analysis also showed that the number of days of lost work, restricted activity days, bed days, and physician visits attributable to obesity increased substantially from 1988 to 1994.[10] Burton et al[15] evaluated the loss in productivity associated with overweight and obesity in a large US financial institution and found that overweight and obese employees had twice as many sick days as employees with lower body weights.

The present study was undertaken to obtain updated evidence on the economic costs of obesity to large, self-insured employers. We evaluate the direct and indirect costs incurred by five separate BMI groups in an employed population, representing a spectrum of weight and obesity, from the underweight to the severely obese. The assessment of costs incurred by five separate BMI groups has the potential to reveal distinctions between groups that might otherwise be obscured. Further, our research draws on rich, current data sources, including administrative claims with detailed expenditure information for precise cost assessments; self-reported health risk assessments (HRAs) that capture height, weight, and BMI; and productivity data from 2003 to 2005, to detail the most current costs in productivity and output.

Materials and Methods

Data Sources

This retrospective analysis used self-reported HRA and work loss data linked to medical claims for employees with both medical and pharmacy benefits obtained from MarketScan Research databases, which are derived from employer and government-funded health insurance plans in the United States. HRA data are derived from the MarketScan HRA Database, which is comprised of linked HRAs and medical claims from nine large US employers for the period from 2003 to 2005. The study sample was comprised of all workers in the database that reported their height and weight on an HRA and that were enrolled in a health benefit plan for all the 12 months of the year in which they completed the HRA.

Where available, the HRA data were linked to employee's work loss data in the MarketScan Health and Productivity Management Database to allow for the assessment of the relationship between BMI and work loss due to absence. The Health and Productivity Management Database contains workplace absence data linked to medical and pharmacy utilization data from large US employers. Three of nine employers providing HRA data also reported data on time lost from work, providing such data for 10,646 employees, or approximately 12% of the larger study sample.

Study Cohorts

We determined the direct and indirect costs of obesity by calculating medical care resource utilization, associated medical costs, work loss, and associated indirect costs within distinct BMI groups. BMI is a measure of weight scaled according to height and was calculated as the ratio in kilograms to the square of height in meters. Workers were categorized by their level of BMI according to the categories set by the US Centers for Disease Control and for the severely obese category, the World Health Organization,[16] as follows: severely obese (BMI $\geq$35), obese ($30 \leq$ BMI $<$ 35), overweight ($25 \leq$ BMI $<$ 30), normal weight ($18.5 \leq$ BMI $<$ 25), and underweight (BMI $<$18.5).

Employees with outlying values of height or weight were excluded from the analysis because their BMI was considered to be unreliable. Out of range values for height were those less than 40 and greater than 90 inches. Out of range values for BMI were those less than 10 and greater than 80. For the purposes of the analysis, we assumed that BMI, calculated from self-reported weight and height, is directionally correct, in that any reporting bias up or down is independent of the true level of obesity.

Health Care Utilization, Work Loss, and Cost Measures

Health care utilization was classified by type of service, including inpatient, emergency room, outpatient, and outpatient pharmacy. Utilization of inpatient services was measured both by the number of admissions and in days, emergency room and outpatient services in visits, and outpatient pharmacy in the number of prescriptions dispensed. Costs of all types of services were calculated as the amounts paid by primary and secondary insurers and by patients (ie, copayments and deductibles). Because the data spanned the years 2003 to 2005, all costs were adjusted to 2005 price levels using the medical care component of the Consumer Price Index.

Work loss is represented by paid time off (including sick time). The work loss data contained detailed information about each employee's

absence from work, including hours missed from work, the dates of absence, and the type of absence. Because cost estimates for absence from work are not included in the employer's absenteeism files, the cost of absenteeism was calculated by multiplying the hours absent by $26.46, the December 2005 BLS average hourly wage and benefit rate for all industries.[17] The product of the number of hours absent and the average hourly wage and benefit rate was multiplied by eight to arrive at an estimated cost per day associated with paid time off.

Data Analyses

Frequency distributions, means, and standard deviations were used to describe the study population. Comparisons between employees in the five BMI groups were made for several characteristics. Workers at each BMI level were compared on medical care utilization, work loss, and the direct and indirect costs incurred for the calendar year in which the employee completed the HRA.

Differences in health care expenditures and costs associated with work loss across the BMI groups were assessed by means of two-part multiple regression analyses. The models estimating health care expenditures adjusted for age, age-squared, sex, geographic region, salary or hourly pay, union or nonunion status, industry type, health plan type (capitated health plan or other), and year. The models estimating costs due to work loss adjusted for age, age-squared, sex, geographic region, and year. Each two-part model consisted of a logistic regression model that estimated the probability of incurring positive dollars in each category of expenditure (ie, direct or indirect costs) and a log-gamma general linear model (GLM) that predicted the amount of expenditure among those with expenditure. The predicted probability of having any expenditure (obtained from the first model) was multiplied by the predicted magnitude of the expenditure (obtained from the second model) to obtain the total predicted medical or work loss expenditure. The expected level of costs is given by

$$E[y_i|X_i] = pr(y_i > 0 \mid X_{1i}) \times E[y_i \mid y_i > 0, X_{2i})$$

Estimates of the adjusted incremental costs of each BMI group, relative to the normal weight group, were obtained by using the MFX command, a Stata (Stata Corp, College Station, TX) module designed to obtain marginal or incremental effects of the independent variables.[18] The incremental costs were estimated for each of the BMI groups at the means of the covariates.

Results

Patient Characteristics

The study population consisted of 88,984 employees, of whom 34% were aged 45 and above and 55% were male. Approximately one third of the sample was of normal weight (34.02%), less than 1% was underweight (0.95%), and the remainder were either overweight (38.50%), obese (16.67%), or severely obese (9.87%) (Table 1).

Univariate analysis showed several differences between employees of different BMI groups. Mean age increased with increasing levels of BMI, and whereas greater proportions of men were overweight or obese, a higher proportion of women were severely obese. As shown in Fig. 1, the prevalence of a variety of conditions of major organ systems increases with increasing levels of BMI, including conditions of the musculoskeletal system, respiratory system, as well as endocrine, nutritional, and metabolic diseases and disorders. (The classes of conditions displayed in Fig. 1 represent chapters of the International Classification of Diseases, 9th revision—Clinical

TABLE 1
Demographic Characteristics of Study Cohort

	Severely Obese (BMI ≥35)		Obese (30 ≤ BMI < 35)		Overweight (25 ≤ BMI < 30)		Normal Weight (18.5 ≤ BMI < 25)		Underweight (BMI <18.5)	
	N	%/SD	*N*	%/SD	*N*	%/SD	*N*	%/SD	*N*	%/SD
All members	8,780		14,826		34,259		30,276		843	
Age										
Mean age (SD)	43	9.4	42.9	9.3	41.9	9.4	39.6	9.7	37.4	9.9
Gender										
Male	3,754	42.80%	9,260	62.50%	23,499	68.60%	12,273	40.50%	168	19.90%
Female	5,026	57.20%	5,566	37.50%	10,760	31.40%	18,003	59.50%	675	80.10%
Health plan type										
HMO	3,399	38.70%	3,953	26.70%	8,561	25.00%	8,389	27.70%	233	27.60%
PPO	4,731	53.90%	9,253	62.40%	20,603	60.10%	16,196	53.50%	438	52.00%
Other	650	7.40%	1,620	10.90%	5,095	14.90%	5,691	18.80%	172	20.40%
Industry sector										
Manufacturing	5,001	57.00%	10,420	70.30%	24,932	72.80%	21,006	69.40%	590	70.00%
Service	3,779	43.00%	4,406	29.70%	9,327	27.20%	9,270	30.60%	253	30.00%

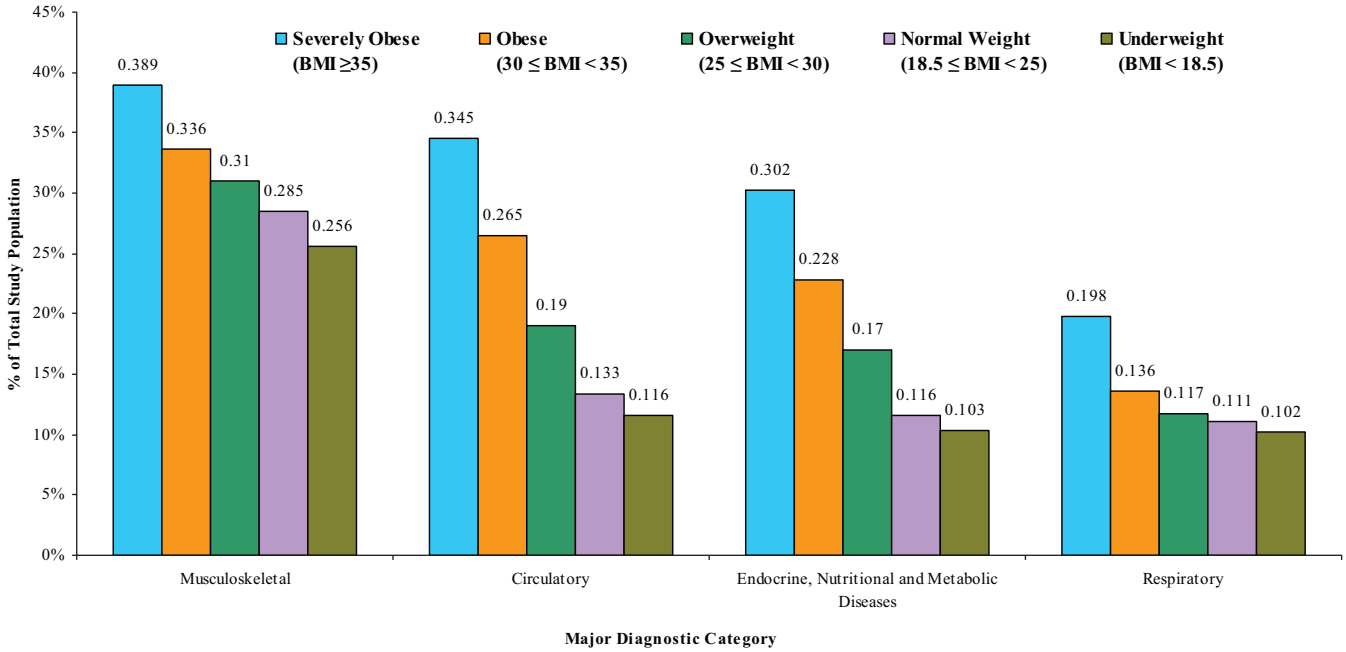

Fig. 1. Prevalence of conditions within selected major diagnostic categories.

Modification (ICD-9-CM) manual. Claims histories of all patients were reviewed for the study period for the presence of any ICD-9-CM code contained in the reported chapters.)

Direct and Indirect Costs

As shown in Table 2, the severely obese, obese, and underweight groups used more medical services and incurred higher costs in all service categories than did the normal weight group. With the exception of outpatient prescriptions, the overweight group had lower utilization rates in all service categories compared with the normal weight group. Accordingly, unadjusted annual health care costs were higher within the severely obese, obese, and underweight groups when compared with the normal weight group (72%, 20%, and 11% higher, respectively). In our sample of workers, total unadjusted annual health care costs per person were similar for normal and overweight individuals ($3248 and $3199, respectively) and were elevated at either end of the BMI spectrum.

As shown in Table 2, the severely obese, obese, and overweight groups experienced more work loss due to paid time off than did normal weight group. Accordingly, indirect costs due to paid time off were higher within the severely obese, obese, and overweight groups when compared with the normal weight group.

Regression-Adjusted Estimates

Results of the multivariate analysis of direct medical expenditures are summarized in Fig. 2. Relative to the normal weight group, the estimated odds of incurring any medical expenditure were higher for the overweight, obese, and severely obese groups by approximately 10%, 24%, and 48%, respectively (odds ratios of 1.10, 1.24, and 1.48, respectively). In contrast, underweight workers were roughly half as likely to have incurred direct medical expenditures as their normal weight counterparts.

We used log-gamma regression to assess associations between direct medical costs and the BMI groups among those who incurred positive medical expenditure. Figure 2 presents the estimates of incremental direct costs for each BMI group, adjusted for differences in the covariates in the log-gamma model. The incremental cost of being underweight is estimated at $409.35. The incremental costs of being overweight, obese, and severely obese are estimated at $147.11, $712.34, and $1977.43, respectively.

Results of the multivariate analysis of the indirect costs are summarized in Fig. 3. Relative to the normal weight group, the estimated odds of incurring positive expenditure due to paid time off were higher for the underweight, overweight, obese, and severely obese groups by approximately 21%, 68%, 194%, and 278%, respectively (odds ratios of 1.21, 1.68, 2.94, and 3.78, respectively).

Consistent with the direct cost models, we used log-gamma regression to assess associations between indirect costs due to work loss and the BMI subgroups among those who incurred positive indirect costs. Figure 3 reports the estimates of incremental indirect costs for each BMI group, adjusted for differences in the covariates in the log-gamma

TABLE 2
Medical Care Resource Utilization, Lost Productivity, and Associated Direct and Indirect Costs, by BMI Group

	Severely Obese (BMI ≥35)		Obese (30 ≤ BMI <35)		Overweight (25 ≤ BMI < 30)		Normal Weight (18.5 ≤ BMI < 25)		Underweight (BMI <18.5)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Medical care resource utilization										
Inpatient hospital admissions	0.3	2.7	0.2	1.6	0.1	1.0	0.2	1.3	0.2	1.3
Emergency department (# of visits)	0.7	2.7	0.4	1.8	0.4	1.9	0.4	2.1	0.6	5.4
Physician office visits (# of visits)	4.6	4.7	3.6	4.1	3.0	3.6	3.1	3.7	3.4	4.2
Other outpatient services (# of services)	20.8	28.6	16.4	24.3	14.4	22.7	15.8	24.1	17.5	25.0
Outpatient pharmacy (# of dispensings)	17.1	19.0	12.1	15.4	9.4	12.7	9.2	11.6	9.7	13.4
Medical care costs										
Inpatient hospital	$1,168	$8,232	$718	$5,201	$530	$4,600	$557	$5,743	$833	$5,686
Emergency department	$136	$549	$100	$483	$81	$421	$77	$440	$99	$494
Physician office	$363	$388	$280	$329	$241	$300	$249	$330	$282	$375
Other outpatient services	$2,619	$6,781	$1,898	$1,898	$1,586	$4,605	$1,636	$5,085	$1,590	$3,775
Outpatient pharmacy	$1,344	$2,445	$965	$1,716	$761	$1,586	$729	$1,729	$802	$2,356
Total	$5,629	$12,999	$3,959	$8,650	$3,199	$7,669	$3,248	$9,058	$3,606	$8,778
Number of work days lost										
Absence/paid time off	37.8	64.8	36.5	65.0	27.5	58.2	15.9	38.8	11.1	13.2
Estimated costs of work days lost										
Absence/paid time off	$8,433	$14,279	$8,230	$14,412	$6,150	$12,961	$3,488	$8,652	$2,406	$2,814

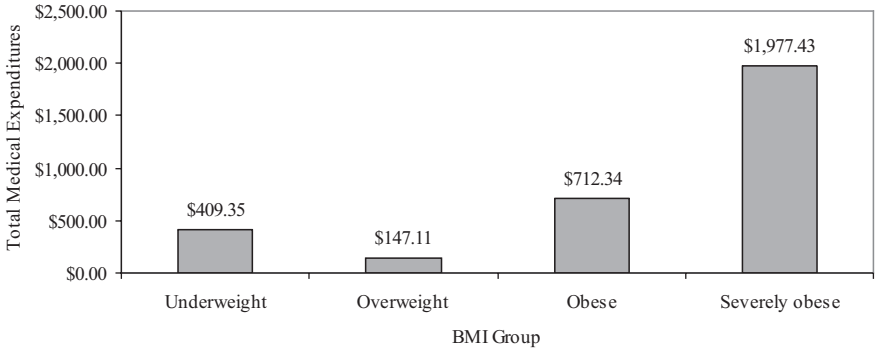

Fig. 2. Marginal effects ($) of the GLM of total medical expenditures.

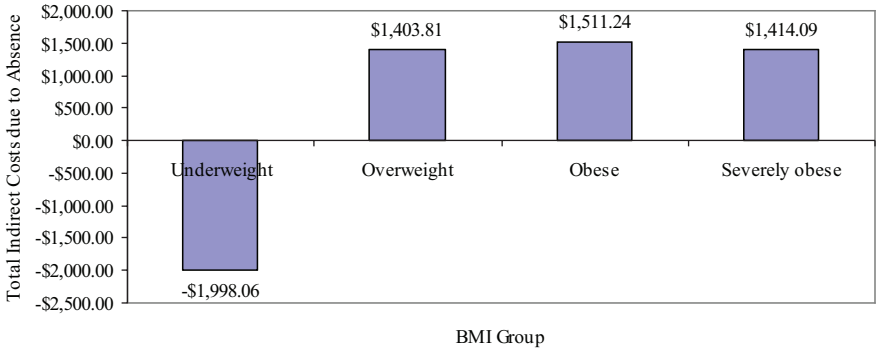

Fig. 3. Marginal effects ($) of the GLM of indirect costs due to absence, relative to the normal weight BMI group.

model. The incremental indirect costs associated with paid time off of being overweight, obese, and severely obese are estimated at $1403.81, $1511.24, and $1414.09, respectively.

Discussion

Using current self-reported HRA, claims, and employee productivity data, the present analysis evaluated the direct health care and indirect costs due to paid time off from work incurred by workers within a complete range of BMI groups. Consistent with previous research,[15,19] our analysis revealed that overall health care costs (medical and pharmaceutical) were higher for workers who were obese or severely obese than for those of normal weight. Further, indirect costs due to paid time off were higher for those who were overweight, obese, or severely obese, when compared with those of normal weight. In contrast, we find that the health care costs of the overweight

are similar to those of normal weight in our study population.

A significant contribution of the present study is our assessment of the health care and indirect costs to employers associated with various categories of BMI. Previous work examining the costs of overweight and obesity often focus on national spending attributable to these conditions; payer-specific estimates are less widely available. The few employer-specific analyses available in the literature are at this point dated.[20,21] Our study provides current estimates of the costs to large US employers attributable to distinct BMI groups.

A second contribution of the present study is the assessment of costs associated with distinct weight groups based on BMI. A number of previous studies have estimated the costs of overweight and obesity as the sum of the costs attributable to obesity-related chronic conditions, such as type 2 diabetes and cardiovascular disease.[10,12] Although overweight and obesity are major risk factors of these conditions, it cannot be assumed that the total costs associated with them are, in fact, obesity-attributable.

Our results suggest the need to distinguish gradations of BMI, particularly, the overweight from the obese and severely obese, in health economics and health services research. A binary classification scheme (ie, obese or not) observed in previous work[6,22] may obscure important similarities or differences in costs of various weight groups. For example, the present study finds similarities in the health care and indirect costs of overweight and normal weight employees, but differences in costs that are pronounced at both ends of the BMI continuum.

This analysis has several limitations. First, our measure of BMI was obtained via the voluntary, self-reported HRA. Inaccuracies of self-reported height and weight are indicated in the literature, specifically the tendency for individuals to underestimate their weight and overestimate their height.[23,24] Such potential bias in reporting suggests that these data be interpreted with caution. Second, although the strength of the present study is its large and diverse sample of employees, it should be noted that the sample was not randomly selected. A third limitation of our study is the reliance on paid time off as the sole measure of work loss. Additional sources of productivity loss, including short-term disability and presenteeism, may provide a more comprehensive understanding of the indirect costs associated with obesity, represents a potentially fruitful avenue for future research.

In summary, obesity imposes a significant societal and employer burden, as indicated by the greater health care utilization, higher direct medical costs, and more time lost from work of those who are obese or severely obese. Given the multiple links between obesity and a range of chronic health problems, interventions that reduce the prevalence of obesity are likely to simultaneously reduce the prevalence of its comorbid conditions, including dyslipidemia and type 2 diabetes. Reductions in the prevalence of such conditions could prove beneficial to patients, employers, and insurers.

Acknowledgment

Supported in part by Sanofi-aventis Pharmaceuticals.

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